

WHAT IS CLAIMED IS:

1. An optical switch, comprising:
  - a substrate;
  - a first slab layer and a second slab layer disposed over the substrate;
  - a third slab layer disposed over the substrate and positioned between the first slab layer and the second slab layer; and
  - a phase control area provided for any one of the first slab layer, the second slab layer and the third slab layer, and controlling a phase of light passing through the respective slab layer,
  - each of the slab layers comprising:
    - a two-dimensional photonic crystal structure in which low refraction index areas are arranged periodically;
    - a linear defect that is formed in a part of the two-dimensional photonic structure and functions as a waveguide;
    - a point defect for emitting light, which is formed within the two-dimensional photonic crystal structure, captures light of a specific wavelength from the linear defect, and emits the light; and
    - a point defect for trapping light, which is formed within the two-dimensional photonic crystal structure, captures light of a specific wavelength, and traps the light into the linear defect,
  - the point defect for trapping light in each of the first slab layer and the second slab layer and the point defect for emitting light in the third slab layer being positioned so as to face each other, and the point defect for emitting light in each of the first slab layer and the second slab layer and the point defect for trapping light in the third slab layer being positioned so as to face each other.
2. The optical switch according to Claim 1, the first slab layer and the second slab layer comprising a plurality of first slab layers and a plurality of second slab layers, respectively;
  - the point defects being formed in the plurality of first slab layers and of second slab layers so as to capture light rays having different wavelengths;
  - the point defect corresponding to the point defect formed in each of the plurality of first slab layers and of second slab layers being formed in the third slab layer; and

the first slab layer and the second slab layer each provided with a point defect that captures light of a same wavelength being positioned so as to have a same distance from the third slab layer.

3. An optical switch, comprising:

a substrate;

a first slab layer and a second slab layer disposed over the substrate; and

a phase control area provided for any one of the first slab layer and the second slab layer, and controlling a phase of light passing through the respective slab layer,

each of the slab layers comprising:

a two-dimensional photonic crystal structure in which low refraction index areas are arranged periodically; and

a linear defect that is formed in a part of the two-dimensional photonic crystal structure and functions as a wave guide,

the first slab layer comprising a plurality of first slab layers formed within the two-dimensional photonic crystal structure and includes a point defect for emitting light that captures light of a specific wavelength from the linear defect and emitting the light, wherein

the second slab layer comprises a plurality of second slab layers formed within the two-dimensional photonic crystal structure and includes a point defect for trapping light that captures light of a specific wavelength and traps the light into the linear defect, and

the point defect for emitting light in the first slab layer and the point defect for trapping light in the second slab layer being positioned so as to face each other.

4. An optical switch, comprising:

a substrate;

a first slab layer and a second slab layer disposed over the substrate; and

a phase control area provided for any one of the first slab layer and the second slab layer, and controlling a phase of light passing through the respective slab layer,

each of the slab layers comprising:

a two-dimensional photonic crystal structure in which low refraction index areas are arranged periodically;

a linear defect that is formed in a part of the two-dimensional photonic crystal structure and functions as a waveguide;

a point defect that is formed within the two-dimensional photonic crystal structure, captures light of a specific wavelength from the linear defect and emits the light; and

a point defect that is formed within the two-dimensional photonic crystal structure, captures light of a specific wavelength and traps the light into the linear defect, the point defect that emits light in the first slab layer and the point defect that traps light in the second slab layer being positioned so as to face each other, and

the point defect that traps light in the first slab layer and the point defect that emits light in the second slab layer being positioned so as to face each other.

5. The optical switch according to Claim 3,  
the second slab layer comprising the plurality of second slab layers,  
the point defect for trapping light, which is formed in each of the plurality of second slab layers so as to capture a wavelength different from another wavelength captured by another point defect, and

the point defect that emits light corresponding to the point defect for trapping light, which is formed in each of the plurality of second slab layers being formed in the first slab layer.

6. The optical switch according to Claim 1, the phase control area being capable of controlling a phase of light by varying a refraction index of the linear defect.

7. The optical switch according to Claim 6, the phase control area comprising a pair of electrodes and varying the refraction index of the linear defect by an electric field applied from the pair of electrodes.

8. The optical switch according to Claim 6, the phase control area comprising a heating portion and varying the refraction index of the linear defect by heat applied from the heating portion.

9. The optical switch according to Claim 1, a wavelength of captured light being different depending on a shape of the point defect.

10. The optical switch according to Claim 1, the point defect comprising a vertically asymmetric columnar structure.

11. The optical switch according to Claim 1, a reflecting member that reflects light of the specific wavelength being placed on the bottom of defects in with respect to the surface of the slab layer.

12. The optical switch according to Claim 1, further comprising a cladding layer having a refraction index lower than that of a material for the slab layer on each of an upper and a lower sides of each of the slab layer.

13. The optical switch according to Claim 1, one end or both ends of the linear defect being closed with the low refraction index areas arranged periodically.

14. The optical switch according to Claim 1, the linear defect included in the slab layer being positioned not so as to overlap another linear defect in another slab layer disposed at least on an upper side or lower side of the slab layer.

15. The optical switch according to Claim 1, the low refraction index areas being arranged in one of a triangle lattice pattern and in a square lattice pattern.

16. The optical switch according to Claim 1, each of the low refraction index areas comprising at least one of a indented section and a through hole formed in the slab layer.

17. An optical communications device comprising the optical switch described in Claim 1.

18. An optical communications system comprising the optical switch described in Claim 1.

19. The optical switch according to Claim 4,  
the second slab layer comprising the plurality of second slab layers,  
the point defect that traps light being formed in each of the plurality of second slab layers so as to capture a wavelength different from another wavelength captured by another point defect, and

the point defect that emits light corresponding to the point defect that traps light formed in each of the plurality of second slab layers being formed in the first slab layer.

20. The optical switch according to Claim 3, the phase control area being capable of controlling a phase of light by varying a refraction index of the linear defect.

21. The optical switch according to Claim 4, the phase control area being capable of controlling a phase of light by varying a refraction index of the linear defect.